



Common Market for Eastern and Southern Africa



EDICT OF GOVERNMENT



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COMESA 020 (2004) (English): Standard for
Named Vegetable Oils



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COMESA HARMONISED
STANDARD

COMESA/FDHS
020:2004

Standard for Named Vegetable Oils

REFERENCE: FDHS 020:2004

CODEX STANDARD FOR NAMED VEGETABLE OILS

CODEX STAN 210 - 1999

The Appendix to this standard is intended for voluntary application by commercial partners and not for application by governments.

1 Scope

This standard applies to the vegetable oils described in section 2.1 presented in a state for human consumption.

2 Description

2.1 Product definitions

(Note: synonyms are in brackets immediately following the name of the oil)

2.1.1

Arachis oil (peanut oil; groundnut oil) is derived from groundnuts (seeds of *Arachis hypogaea* L.).

2.1.2

Babassu oil is derived from the kernel of the fruit of several varieties of the palm *Orbignya* spp.

2.1.3

Coconut oil is derived from the kernel of the coconut (*Cocos nucifera* L.).

2.1.4

Cottonseed oil is derived from the seeds of various cultivated species of *Gossypium* spp.

2.1.5

Grapeseed oil is derived from the seeds of the grape (*Vitis vinifera* L.).

2.1.6

Maize oil (corn oil) is derived from maize germ (the embryos of *Zea mays* L.).

2.1.7

Mustardseed oil is derived from the seeds of white mustard (*Sinapis alba* L. or *Brassica hirta* Moench), brown and yellow mustard (*Brassica juncea* (L.) Czernajew and Cossen) and of black mustard (*Brassica nigra* (L.) Koch).

2.1.8

Palm kernel oil is derived from the kernel of the fruit of the oil palm (*Elaeis guineensis*).

2.1.9

Palm oil is derived from the fleshy mesocarp of the fruit of the oil palm (*Elaeis guineensis*).

2.1.10

Palm olein is the liquid fraction derived from the fractionation of palm oil (described above).

2.1.11

Palm stearin is the high-melting fraction derived from the fractionation of palm oil (described above).

2.1.12

Rapeseed oil (turnip rape oil; colza oil; ravison oil; sarson oil; toria oil) is produced from seeds of *Brassica napus* L., *Brassica campestris* L., *Brassica juncea* L. and *Brassica tournefortii* Gouan species.

2.1.13

Rapeseed oil - low erucic acid (low erucic acid turnip rape oil; low erucic acid colza oil; canola oil) is produced from low erucic acid oil-bearing seeds of varieties derived from the *Brassica napus* L., *Brassica campestris* L. and *Brassica juncea* L., species.

2.1.14

Safflowerseed oil (safflower oil; carthamus oil; kurdee oil) is derived from safflower seeds (seeds of *Carthamus tinctorius* L.).

2.1.15

Safflowerseed oil - high oleic acid (high oleic acid safflower oil; high oleic acid carthamus oil; high oleic acid kurdee oil) is produced from high oleic acid oil-bearing seeds of varieties derived from *Carthamus tinctorius* L.

2.1.16

Sesameseed oil (sesame oil; gingelly oil; benne oil; ben oil; till oil; tillie oil) is derived from sesame seeds (seeds of *Sesamum indicum* L.).

2.1.17

Soya bean oil (soybean oil) is derived from soya beans (seeds of *Glycine max* (L.) Merr.).

2.1.18

Sunflowerseed oil (sunflower oil) is derived from sunflower seeds (seeds of *Helianthus annuus* L.).

2.1.19

Sunflowerseed oil - high oleic acid (high oleic acid sunflower oil) is produced from high oleic acid oil-bearing seeds of varieties derived from sunflower seeds (seeds of *Helianthus annuus* L.).

2.2 Other definitions**2.2.1**

Edible vegetable oils are foodstuffs which are composed primarily of glycerides of fatty acids being obtained only from vegetable sources. They may contain small amounts of other lipids such as phosphatides, of unsaponifiable constituents and of free fatty acids naturally present in the fat or oil.

2.2.2

Virgin oils are obtained, without altering the nature of the oil, by mechanical procedures, e.g. expelling or pressing, and the application of heat only. They may have been purified by washing with water, settling, filtering and centrifuging only.

2.2.3

Cold pressed oils are obtained, without altering the oil, by mechanical procedures only, e.g. expelling or pressing, without the application of heat. They may have been purified by washing with water, settling, filtering and centrifuging only.

3 Essential composition and quality factors**3.1 GLC ranges of fatty acid composition (expressed as percentages)**

Samples falling within the appropriate ranges specified in Table 1 are in compliance with this standard. Supplementary criteria, for example national geographical and/or climatic variations, may be considered, as necessary, to confirm that a sample is in compliance with the standard.

3.1.1 Low-erucic acid rapeseed oil must not contain more than 2% erucic acid (as % of total fatty acids).

3.1.2 High oleic acid safflower oil must contain not less than 70% oleic acid (as a % of total fatty acids).

3.1.3 High oleic acid sunflower oil must contain not less than 75% oleic acid (as % of total fatty acids).

3.3 Slip point

| | |
|--------------|--------------------|
| Palm olein | not more than 24°C |
| Palm stearin | not less than 44°C |

4 Food additives

4.1 No food additives are permitted in virgin or cold pressed oils.

4.2 Flavours

Natural flavours and their identical synthetic equivalents, and other synthetic flavours, except those which are known to represent a toxic hazard.

4.3 Antioxidants

| | | Maximum level |
|-----|------------------------------------|----------------------------------|
| 304 | Ascorbyl palmitate |) 500 mg/kg |
| 305 | Ascorbyl stearate |) individually or in combination |
| 306 | Mixed tocopherols concentrate | GMP |
| 307 | Alpha-tocopherol | GMP |
| 308 | Synthetic gamma-tocopherol | GMP |
| 309 | Synthetic delta-tocopherol | GMP |
| 310 | Propyl gallate | 100 mg/kg |
| 319 | Tertiary butyl hydroquinone (TBHQ) | 120 mg/kg |

| | | |
|-----|--|---|
| 320 | Butylated hydroxyanisole (BHA) | 175 mg/kg |
| 321 | Butylated hydroxytoluene (BHT) | 75 mg/kg |
| | Any combination of gallates, BHA and BHT and/or TBHQ | 200 mg/kg but limits above not to be exceeded |
| 389 | Dilauryl thiodipropionate | 200 mg/kg |

4.4 Antioxidant Synergists

| | | |
|-----|---|---|
| 330 | Citric acid | GMP |
| 331 | Sodium citrates | GMP |
| 384 | Isopropyl citrates Monoglyceride citrate |) 100 mg/kg individually or in combination) |

4.5 Anti-foaming agents (oils for deepfrying)

| | | |
|------|----------------------|----------|
| 900a | Polydimethylsiloxane | 10 mg/kg |
|------|----------------------|----------|

5 Contaminants

5.1 Heavy metals

The products covered by the provisions of this standard shall comply with maximum limits being established by the Codex Alimentarius Commission but in the meantime the following limits will apply:

Maximum permissible concentration

| | |
|--------------|-----------|
| Lead (Pb) | 0.1 mg/kg |
| Arsenic (As) | 0.1 mg/kg |

5.2 Pesticide residues

The products covered by the provisions of this standard shall comply with those maximum residue limits established by the Codex Alimentarius Commission for these commodities.

6 Hygiene

- 6.1 It is recommended that the products covered by the provisions of this standard be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Practice –General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 3-1997), and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.
- 6.2 The products should comply with any microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria for Foods (CAC/GL 21-1997).

7 Labelling

7.1 Name of the food

The product shall be labelled in accordance with the Codex General Standard for the Labelling of Prepackaged Foods (CODEX STAN 1-1985, Rev. 1-1991). The name of the oil shall conform to the descriptions given in section 2 of this standard.

Where more than one name is given for a product in section 2.1, the labelling of that product must include one of those names acceptable in the country of use.

7.2 Labelling of non-retail containers

Information on the above labelling requirements shall be given either on the container or in accompanying documents, except that the name of the food, lot identification and the name and address of the manufacturer or packer shall appear on the container.

However, lot identification and the name and address of the manufacturer or packer may be replaced by an identification mark, provided that such a mark is clearly identifiable with the accompanying documents.

8 Methods of analysis and sampling

8.1 Determination of GLC ranges of fatty acid composition

According to IUPAC 2.301, 2.302 and 2.304 or ISO 5508: 1990 and 5509: 2000 or AOCS Cc 2-66, Ce 1e-91 or Ce 1f-96.

8.2 Determination of slip point

According to ISO 6321: 1991 and Amendment 1: 1998 for all oils, or AOCS Cc 3b-92 or Ce 3-25 (97) for palm oils only.

8.3 Determination of arsenic

According to AOAC 952.13, IUPAC 3.136, AOAC 942.17, or AOAC 985.16.

8.4 Determination of lead

According to IUPAC 2.632, AOAC 994.02 or ISO 12193: 1994 or AOCS Ca 18c-91.

Table 1: Fatty acid composition of vegetable oils as determined by gas liquid chromatography from authentic samples¹ (expressed as percentage of total fatty acids) (see section 3.1 of the standard)

| Fatty acid | Arachis oil | Babassu oil | Coconut oil | Cottonseed oil | Grapeseed oil | Maize oil | Mustardseed oil | Palm oil | Palm kernel oil | Palm olein |
|------------|-------------|-------------|-------------|----------------|---------------|-----------|-----------------|-----------|-----------------|------------|
| C6:0 | ND | ND | ND-0.7 | ND | ND | ND | ND | ND | ND-0.8 | ND |
| C8:0 | ND | 2.6-7.3 | 4.6-10.0 | ND | ND | ND | ND | ND | 2.4-6.2 | ND |
| C10:0 | ND | 1.2-7.6 | 5.0-8.0 | ND | ND | ND | ND | ND | 2.6-5.0 | ND |
| C12:0 | ND-0.1 | 40.0-55.0 | 45.1-53.2 | ND-0.2 | ND | ND-0.3 | ND | ND-0.5 | 45.0-55.0 | 0.1-0.5 |
| C14:0 | ND-0.1 | 11.0-27.0 | 16.8-21.0 | 0.6-1.0 | ND-0.3 | ND-0.3 | ND-1.0 | 0.5-2.0 | 14.0-18.0 | 0.5-1.5 |
| C16:0 | 8.0-14.0 | 5.2-11.0 | 7.5-10.2 | 21.4-26.4 | 5.5-11.0 | 8.6-16.5 | 0.5-4.5 | 39.3-47.5 | 6.5-10.0 | 38.0-43.5 |
| C16:1 | ND-0.2 | ND | ND | ND-1.2 | ND-1.2 | ND-0.5 | ND-0.5 | ND-0.6 | ND-0.2 | ND-0.6 |
| C17:0 | ND-0.1 | ND | ND | ND-0.1 | ND-0.2 | ND-0.1 | ND | ND-0.2 | ND | ND-0.2 |
| C17:1 | ND-0.1 | ND | ND | ND-0.1 | ND-0.1 | ND-0.1 | ND | ND | ND | ND-0.1 |
| C18:0 | 1.0-4.5 | 1.8-7.4 | 2.0-4.0 | 2.1-3.3 | 3.0-6.5 | ND-3.3 | 0.5-2.0 | 3.5- 6.0 | 1.0-3.0 | 3.5-5.0 |
| C18:1 | 35.0-69 | 9.0-20.0 | 5.0-10.0 | 14.7-21.7 | 12.0-28.0 | 20.0-42.2 | 8.0-23.0 | 36.0-44.0 | 12.0-19.0 | 39.8-46.0 |
| C18:2 | 12.0-43.0 | 1.4-6.6 | 1.0-2.5 | 46.7-58.2 | 58.0-78.0 | 34.0-65.6 | 10.0-24.0 | 9.0-12.0 | 1.0-3.5 | 10.0-13.5 |
| C18:3 | ND-0.3 | ND | ND-0.2 | ND-0.4 | ND-1.0 | ND-2.0 | 6.0-18.0 | ND-0.5 | ND-0.2 | ND-0.6 |
| C20:0 | 1.0-2.0 | ND | ND-0.2 | 0.2-0.5 | ND-1.0 | 0.3-1.0 | ND-1.5 | ND-1.0 | ND-0.2 | ND-0.6 |
| C20:1 | 0.7-1.7 | ND | ND-0.2 | ND-0.1 | ND-0.3 | 0.2-0.6 | 5.0-13.0 | ND-0.4 | ND-0.2 | ND-0.4 |
| C20:2 | ND | ND | ND | ND-0.1 | ND | ND-0.1 | ND-1.0 | ND | ND | ND |
| C22:0 | 1.5-4.5 | ND | ND | ND-0.6 | ND-0.5 | ND-0.5 | 0.2-2.5 | ND-0.2 | ND-0.2 | ND-0.2 |
| C22:1 | ND-0.3 | ND | ND | ND-0.3 | ND-0.3 | ND-0.3 | 22.0-50.0 | ND | ND | ND |
| C22:2 | ND | ND | ND | ND-0.1 | ND | ND | ND-1.0 | ND | ND | ND |
| C24:0 | 0.5-2.5 | ND | ND | ND-0.1 | ND-0.4 | ND-0.5 | ND-0.5 | ND | ND | ND |
| C24:1 | ND-0.3 | ND | ND | ND | ND | ND | 0.5-2.5 | ND | ND | ND |

ND - non-detectable, defined as 0.05%

¹ Data taken from species as listed in section 2.

Table 1: Fatty acid composition of vegetable oils as determined by gas liquid chromatography from authentic samples¹ (expressed as percentage of total fatty acids) (see section 3.1 of the standard) (continued)

| Fatty acid | Palm stearin | Rapeseed oil | Rapeseed oil (low erucic acid) | Safflowerseed oil | Safflowerseed oil (high oleic acid) | Sesameseed oil | Soyabean oil | Sunflowerseed oil | Sunflowerseed (high eleic acid) |
|------------|--------------|--------------|--------------------------------|-------------------|-------------------------------------|----------------|--------------|-------------------|---------------------------------|
| C6:0 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| C8:0 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| C10:0 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| C12:0 | 0.1-0.5 | ND | ND | ND | ND-0.2 | ND | ND-0.1 | ND-0.1 | ND |
| C14:0 | 1.0-2.0 | ND-0.2 | ND-0.2 | ND-0.2 | ND-0.2 | ND-0.1 | ND-0.2 | ND-0.2 | ND-0.1 |
| C16:0 | 48.0-74.0 | 1.5-6.0 | 2.5-7.0 | 5.3-8.0 | 3.6-6.0 | 7.9-12.0 | 8.0-13.5 | 5.0-7.6 | 2.6-5.0 |
| C16:1 | ND-0.2 | ND-3.0 | ND-0.6 | ND-0.2 | ND-0.2 | 0.1- 0.2 | ND-0.2 | ND-0.3 | ND-0.1 |
| C17:0 | ND-0.2 | ND-0.1 | ND-0.3 | ND-0.1 | ND-0.1 | ND-0.2 | ND-0.1 | ND-0.2 | ND-0.1 |
| C17:1 | ND-0.1 | ND-0.1 | ND-0.3 | ND-0.1 | ND-0.1 | ND-0.1 | ND-0.1 | ND-0.1 | ND-0.1 |
| C18:0 | 3.9-6.0 | 0.5-3.1 | 0.8-3.0 | 1.9-2.9 | 1.5-2.4 | 4.8-6.1 | 2.0-5.4 | 2.7-6.5 | 2.9-6.2 |
| C18:1 | 15.5-36.0 | 8.0-60.0 | 51.0-70.0 | 8.4-21.3 | 70.0-83.7 | 35.9-42.3 | 17-30 | 14.0-39.4 | 75-90.7 |
| C18:2 | 3.0-10.0 | 11.0-23.0 | 15.0-30.0 | 67.8-83.2 | 9.0-19.9 | 41.5-47.9 | 48.0 -59.0 | 48.3-74.0 | 2.1-17 |
| C18:3 | ND-0.5 | 5.0-13.0 | 5.0-14.0 | ND-0.1 | ND-1.2 | 0.3-0.4 | 4.5-11.0 | ND-0.3 | ND-0.3 |
| C20:0 | ND-1.0 | ND-3.0 | 0.2-1.2 | 0.2- 0.4 | 0.3-0.6 | 0.3-0.6 | 0.1-0.6 | 0.1-0.5 | 0.2-0.5 |
| C20:1 | ND-0.4 | 3.0-15.0 | 0.1-4.3 | 0.1- 0.3 | 0.1-0.5 | ND-0.3 | ND-0.5 | ND-0.3 | 0.1-0.5 |
| C20:2 | ND | ND-1.0 | ND-0.1 | ND | ND | ND | ND-0.1 | ND | ND |
| C22:0 | ND-0.2 | ND-2.0 | ND-0.6 | ND-1.0 | ND-0.4 | ND-0.3 | ND-0.7 | 0.3-1.5 | 0.5-1.6 |
| C22:1 | ND | > 2.0-60.0 | ND-2.0 | ND-1.8 | ND-0.3 | ND | ND-0.3 | ND-0.3 | ND-0.3 |
| C22:2 | ND | ND-2.0 | ND-0.1 | ND | ND | ND | ND | ND-0.3 | ND |
| C24: 0 | ND | ND-2.0 | ND-0.3 | ND-0.2 | ND-0.3 | ND-0.3 | ND-0.5 | ND-0.5 | ND-0.5 |
| C24:1 | ND | ND-3.0 | ND-0.4 | ND-0.2 | ND-0.3 | ND | ND | ND | ND |

ND - non-detectable, defined as $\leq 0.05\%$ ¹ Data taken from species as listed in section 2.

Appendix

Other quality and composition factors

This text is intended for voluntary application by commercial partners and not for application by governments.

1 Quality characteristics

- 1.1 The **colour, odour and taste** of each product shall be characteristic of the designated product. It shall be free from foreign and rancid odour and taste.

Maximum level

| | | |
|-----|---------------------------------|---|
| 1.2 | Matter volatile at 105°C | 0.2 % m/m |
| 1.3 | Insoluble impurities | 0.05 % m/m |
| 1.4 | Soap content | 0.005 % m/m |
| 1.5 | Iron (Fe): | |
| | Refined oils | 1.5 mg/kg |
| | Virgin oils | 5.0 mg/kg |
| 1.6 | Copper (Cu) | |
| | Refined oils | 0.1 mg/kg |
| | Virgin oils | 0.4 mg/kg |
| 1.7 | Acid value | |
| | Refined oils | 0.6 mg KOH/g Oil |
| | Cold pressed and virgin oils | 4.0 mg KOH/g Oil |
| | Virgin palm oils | 10.0 mg KOH/g Oil |
| 1.8 | Peroxide value: | |
| | Refined oils | up to 10 milliequivalents of active oxygen/kg oil |
| | Cold pressed and virgin oils | up to 15 milliequivalents of active oxygen/kg oil |

2 Composition characteristics

- 2.1 The **arachidic and higher fatty acid content** of arachis oil should not exceed 48g/kg.
- 2.2 The **Reichert values** for coconut, palm kernel and babassu oils should be in the ranges 6-8.5, 4-7 and 4.5-6.5, respectively.
- 2.3 The **Polenske values** for coconut, palm kernel and babassu oils should be in the ranges 13-18, 8-12 and 8-10, respectively.
- 2.4 The **Halphen test** for cottonseed oil should be positive.

- 2.5 The **erythrodiol content** of grapeseed oil should be more than 2% of the total sterols.
- 2.6 The **total carotenoids** (as beta-carotene) for unbleached palm oil, unbleached palm olein and unbleached palm stearin should be in the range 500-2000, 550-2500 and 300-1500 mg/kg, respectively.
- 2.7 The **Crismer value** for low erucic acid rapeseed oil should be in the range 67-70.
- 2.8 The **concentration of brassicasterol** in low erucic acid rapeseed oil should be greater than 5% of total sterols.
- 2.9 The **Baudouin test** should be positive for sesameseed oil.

3 Chemical and physical characteristics

Chemical and Physical Characteristics are given in Table 2.

4 Identity characteristics

- 4.1 **Levels of desmethylsterols** in vegetable oils as a percentage of total sterols are given in Table 3.
- 4.2 **Levels of tocopherols and tocotrienols** in vegetable oils are given in Table 4.

5 Methods of analysis and sampling

5.1 Determination of matter volatile at 105°C

According to IUPAC 2.601 or ISO 662: 1998.

5.2 Determination of insoluble impurities

According to IUPAC 2.604 or ISO 663: 2000.

5.3 Determination of soap content

According to BS 684 section 2.5.

5.4 Determination of copper and iron

According to ISO 8294: 1994, IUPAC 2.631 or AOAC 990.05 or AOCS Ca 18b-91.

5.5 Determination of relative density

According to IUPAC 2.101, with the appropriate conversion factor.

5.6 Determination of apparent density

According to ISO 6883: 2000 with the appropriate conversion factor or AOCS Cc 10c-95.

5.7 Determination of refractive index

According to IUPAC 2.102 or ISO 6320: 2000 or AOCS Ce 7-25.

5.8 Determination of Saponification Value (SV)

According to IUPAC 2.202 or ISO 3657: 1988.

5.9 Determination of Iodine Value (IV)

Wijs - according to IUPAC 2.205/1, ISO 3961: 1996, AOAC 993.20, or AOCS Cd 1d-92 (97), or by calculation - AOCS Cd 1b-87 (97). The method to be used for specific named vegetable oils is stipulated in the standard.

5.10 Determination of unsaponifiable matter

According to IUPAC 2.401 (part 1-5) or ISO 3596: 2000 or ISO 18609: 2000.

5.11 Determination of Peroxide Value (PV)

According to IUPAC 2.501 (as amended), AOCS Cd 8b - 90 (97) or ISO 3961: 1998.

5.12 Determination of total carotenoids

According to BS 684 section 2.20.

5.13 Determination of acidity

According to IUPAC 2.201 or ISO 660: 1996 or AOCS Cd 3d-63.

5.14 Determination of sterol content

According to ISO 12228:1999, or IUPAC 2.403.

5.15 Determination of tocopherol content

According to IUPAC 2.432 or ISO 9936: 1997 or AOCS Ce 8-89.

5.16 Halphen test

According to AOCS Cb 1-25 (97).

5.17 Crismer value

According to AOCS Cb 4-35 (97) and AOCS Ca 5a-40 (97).

5.18 Baudouin test (modified villavecchia test or sesameseed oil test)

According to AOCS Cb 2-40 (97).

5.1 Reichert value and polenske value

According to IUPAC 2.204.

Table 2: Chemical and physical characteristics of crude vegetable oils (see Appendix of the standard)

| | Arachis oil | Babassu oil | Coconut oil | Cottonseed oil | Grapeseed oil | Maize oil | Mustardseed oil | Palm oil | Palm kernel |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------------|-----------------------|
| Relative density (x°C/water at 20°C) | 0.912-0.920 x=20°C | 0.914-0.917 x=25°C | 0.908-0.921 x=40°C | 0.918-0.926 x=20°C | 0.920-0.926 x=20°C | 0.917-0.925 x=20°C | 0.910-0.921 x=20°C | 0.891-0.899 x=50°C | 0.899-0.914 x=40°C |
| Apparent density (g/ml) | | | | | | | | 0.889-0.895 (50°C) | |
| Refractive index (ND 40°C) | 1.460-1.465 | 1.448-1.451 | 1.448-1.450 | 1.458-1.466 | 1.467-1.477 | 1.465-1.468 | 1.461-1.469 | 1.454- 1.456 at 50°C | 1.448-1.452 |
| Saponification value (mg KOH/g oil) | 187-196 | 245-256 | 248-265 | 189-198 | 188-194 | 187-195 | 168-184 | 190-209 | 230-254 |
| Iodine value | 86-107 | 10-18 | 6.3-10.6 | 100-123 | 128-150 | 103-135 | 92-125 | 50.0-55.0 | 14.1-21.0 |
| Unsaponifiable matter (g/kg) | ≤ 10 | ≤ 12 | ≤ 15 | ≤ 15 | ≤ 20 | ≤ 28 | ≤ 15 | ≤ 12 | ≤ 10 |
| Stable carbon isotope ratio * | | | | | | -13.71 to -16.36 | | | |

* See the following publications:

Woodbury SP, Evershed RP and Rossell JB (1998). Purity assessments of major vegetable oils based on gamma 13C values of individual fatty acids. *JAACS*, **75** (3), 371-379.

Woodbury SP, Evershed RP and Rossell JB (1998). Gamma 13C analysis of vegetable oil, fatty acid components, determined by gas chromatography-combustion-isotope ratio mass spectrometry, after saponification or regiospecific hydrolysis. *Journal of Chromatography A*, **805**, 249-257.

Woodbury SP, Evershed RP, Rossell JB, Griffith R and Farnell P (1995). Detection of vegetable oil adulteration using gas chromatography combustion / isotope ratio mass spectrometry. *Analytical Chemistry* **67** (15), 2685-2690.

Ministry of Agriculture, Fisheries and Food (1996). Authenticity of single seed vegetable oils. Working Party on Food Authenticity, MAFF, UK.

Table 2: Chemical and physical characteristics of crude vegetable oils (see Appendix of the standard) (continued)

| | Palm olein | Palm stearin | Rapeseed oil | Rapeseed oil (low erucic acid) | Safflowerseed oil | Safflowerseed oil (high oleic acid) | Sesameseed oil | Soyabean oil (high oleic) | Sunglowerseed | Sunflowerseed acid) |
|--|-----------------------|------------------------|-----------------------|---------------------------------------|--------------------------|--|------------------------|----------------------------------|-----------------------|----------------------------|
| Relative density (x° C/water at 20°C) | 0.899-0.920 x=40°C | 0.881-0.891 x=60°C | 0.910-0.920 x=20°C | 0.914-0.920 x=20°C | 0.922-0.927 x=20°C | 0.913-0.919 x=20°C | 0.915- 0.924 x=20°C | 0.919-0.925 x=20°C | 0.918-0.923 x=20°C | 0.909-0.915 x=25°C |
| Apparent density (g/ml) | 0896-0.898 at 40°C | 0.881-0.885 at 60°C | | | | 0.910-0.916 x=25°C | | | | |
| Refractive index (ND 40°C) | 1.458-1.460 | 1.447-1.452 | 1.465-1.469 | 1.465-1.467 | 1.467-1.470 | 1.460-1.464 at 40°C; | 1.465-1.469 | 1.466-1.470 | 1.461- 1.468 | 1.467-1.471 at 25°C |
| | | at 60°C | | | | 1.466-1.470 at 25°C | | | | |
| Saponification value (mg/KOH/g oil) | 194-202 | 193-205 | 168-181 | 182-193 | 186-198 | 186-194 | 186-195 | 189-195 | 188-194 | 182-194 |
| Iodine value | ≥ 56 | ≤ 48 | 94-120 | 105-126 | 136-148 | 80-100 | 104-120 | 124-139 | 118-141 | 78-90 |
| Unsaponifiable matter (g/kg) | ≤ 13 | ≤ 9 | ≤ 20 | ≤ 20 | ≤ 15 | ≤ 10 | ≤ 20 | ≤ 15 | ≤ 15 | ≤ 15 |

Table 3: Levels of desmethylsterols in crude vegetable oils from authentic samples⁴ as a percentage of total sterols (see Appendix 1 of the standard)

| | Arachis oil | Babassu oil | Coconut oil | Cottonseed oil | Grapeseed oil | Maize oil | Palm oil | Palm kernel oil |
|------------------------------|-------------|-------------|-------------|----------------|---------------|------------|-----------|-----------------|
| Cholesterol | ND-3.8 | 1.2-1.7 | ND-3.0 | 0.7-2.3 | ND-0.5 | 0.2-0.6 | 2.6-6.7 | 0.6-3.7 |
| Brassicasterol | ND-0.2 | ND-0.3 | ND-0.3 | 0.1- 0.3 | ND-0.2 | ND-0.2 | ND | ND-0.8 |
| Campesterol | 12.0-19.8 | 17.7-18.7 | 6.0-11.2 | 6.4-14.5 | 7.5-14.0 | 16.0-24.1 | 18.7-27.5 | 8.4-12.7 |
| Stigmasterol | 5.4-13.2 | 8.7-9.2 | 11.4-15.6 | 2.1-6.8 | 7.5-12.0 | 4.3-8.0 | 8.5-13.9 | 12.0-16.6 |
| Beta-sitosterol | 47.4-69.0 | 48.2-53.9 | 32.6-50.7 | 76.0-87.1 | 64.0-70.0 | 54.8-66.6 | 50.2-62.1 | 62.6-73.1 |
| Delta-5-avenasterol | 5.0-18.8 | 16.9-20.4 | 20.0-40.7 | 1.8-7.3 | 1.0-3.5 | 1.5-8.2 | ND-2.8 | 1.4-9.0 |
| Delta-7-stigmastenol | ND-5.1 | ND | ND-3.0 | ND-1.4 | 0.5-3.5 | 0.2-4.2 | 0.2-2.4 | ND-2.1 |
| Delta-7-avenasterol | ND-5.5 | 0.4-1.0 | ND-3.0 | 0.8-3.3 | 0.5-1.5 | 0.3-2.7 | ND-5.1 | ND-1.4 |
| Others | ND-1.4 | ND | ND-3.6 | ND-1.5 | ND-5.1 | ND-2.4 | ND | ND-2.7 |
| Total sterols (mg/kg) | 900-2900 | 500-800 | 400-1200 | 2700-6400 | 2000-70*00 | 7000-22100 | 300-700 | 700-1400 |

| | Rapeseed oil (low erucic acid) | Safflowerseed | Safflowerseed (high oleic acid) | Sesameseed oil | Soyabean oil | Sunflowerseed oil | Sunflowerseed oil (high oleic acid) |
|------------------------------|-----------------------------------|---------------|------------------------------------|-------------------|-----------------|----------------------|--|
| Cholesterol | ND-1.3 | ND- 0.7 | ND-0.5 | 0.1-0.5 | 0.2-1.4 | ND-0.7 | ND-0.5 |
| Brassicasterol | 5.0-13.0 | ND-0.4 | ND-2.2 | 0.1-0.2 | ND-0.3 | ND-0.2 | ND-0.3 |
| Campesterol | 24.7-38.6 | 9.2-13.3 | 8.9-19.9 | 10.1-20.0 | 15.8-24.2 | 6.5-13.0 | 5.0-13.0 |
| Stigmasterol | 0.2-1.0 | 4.5-9.6 | 2.9-8.9 | 3.4-12.0 | 14.9-19.1 | 6.0-13.0 | 4.5-13.0 |
| Beta-sitosterol | 45.1-57.9 | 40.2-50.6 | 40.1-66.9 | 57.7-61.9 | 47.0-60 | 50-70 | 42.0-70 |
| Delta-5-avenasterol | 2.5-6.6 | 0.8-4.8 | 0.2-8.9 | 6.2-7.8 | 1.5-3.7 | ND-6.9 | 1.5- 6.9 |
| Delta-7-stigmastenol | ND-1.3 | 13.7-24.6 | 3.4-16.4 | 0.5-7.6 | 1.4-5.2 | 6.5-24.0 | 6.5-24.0 |
| Delta-7-avenasterol | ND-0.8 | 2.2-6.3 | ND-8.3 | 1.2-5.6 | 1.0-4.6 | 3.0-7.5 | ND-9.0 |
| Others | ND-4.2 | 0.5-6.4 | 4.4-11.9 | 0.7-9.2 | ND-1.8 | ND-5.3 | 3.5-9.5 |
| Total sterols (mg/kg) | 4500-11300 | 2100-4600 | 2000-4100 | 4500-19000 | 1800-4500 | 2400-5000 | 1700-5200 |

⁴ Data taken from species as listed in section 2.ND - non-detectable, defined as $\leq 0.05\%$

Table 4: Levels of tocopherols and tocotrienols in crude vegetable oils from authentic samples⁵ (mg/kg) (see Appendix 1 of the standard)

| | Arachis oil | Babassu oil | Coconut oil | Cottonseed oil | Grapeseed oil | Maize oil | Palm oil | Palm kernel oil |
|--------------------------|--------------------|--------------------|--------------------|-----------------------|----------------------|------------------|-----------------|------------------------|
| Alpha-tocopherol | 49-373 | ND | ND-17 | 136-674 | 16-38 | 23-573 | 4-193 | ND-44 |
| Beta-tocopherol | ND-41 | ND | ND-11 | ND-29 | ND-89 | ND-356 | ND-234 | ND-248 |
| Gamma-tocopherol | 88-389 | ND | ND-14 | 138-746 | ND-73 | 268-2468 | ND-526 | ND-257 |
| Delta-tocopherol | ND-22 | ND | ND | ND-21 | ND-4 | 23-75 | ND-123 | ND |
| Alpha-tocotrienol | ND | 25-46 | ND-44 | ND | 18-107 | ND-239 | 4-336 | ND |
| Gamma-tocotrienol | ND | 32-80 | ND-1 | ND | 115-205 | ND-450 | 4-710 | ND-60 |
| Delta-tocotrienol | ND | 9-10 | ND | ND | ND-3.2 | ND-20 | ND-377 | ND |
| Total (mg/kg) | 170-1300 | 60-130 | ND-50 | 380-1200 | 240-410 | 330-3720 | 150-1500 | ND-260 |

| | Rapeseed oil (low erucic acid) | Safflowerseed | Safflowerseed (high eleic acid) | Sesameseed oil | Soyabean oil | Sunflowerseed oil | Sunflowerseed oil (high oleic acid) |
|--------------------------|---|----------------------|--|---------------------------|-------------------------|------------------------------|--|
| Alpha-tocopherol | 100-386 | 234-660 | 234-660 | ND-3.3 | 9-352 | 403-935 | 400-1090 |
| Beta-tocopherol | ND-140 | ND-17 | ND-13 | ND | ND-36 | ND-45 | 10-35 |
| Gamma-tocopherol | 189-753 | ND-12 | ND-44 | 521-983 | 89-2307 | ND-34 | 3-30 |
| Delta-tocopherol | ND-22 | ND | ND-6 | 4-21 | 154-932 | ND-7.0 | ND-17 |
| Alpha-tocotrienol | ND | ND | ND | ND | ND-69 | ND | ND |
| Gamma-tocotrienol | ND | ND-12 | ND-10 | ND-20 | ND-103 | ND | ND |
| Delta-tocotrienol | ND | ND | ND | ND | ND | ND | ND |
| Total (mg/kg) | 430-2680 | 240-670 | 250-700 | 330-1010 | 600-3370 | 440-1520 | 450-1120 |

ND - Non-detectable.

Note: Maize oil also contains ND-52 mg/kg beta tocotrienol.

⁵ Data taken from species as listed in section 2.